MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 2, 2015/2016

TIT3131 – INFORMATION THEORY

(All sections / Groups)

Question	Marks
TOTAL	

11 MARCH 2016
3.00 pm – 5.00 pm
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This question paper consists of 14 pages with **SIX** questions only.
2. Attempt **FIVE** out of **SIX** questions. All questions carry equal marks and the distribution of the marks for each question is given. If you answer all the questions, the first five questions will be marked only.
3. Please write all your answers in the **blank spaces** provided

QUESTION 1

Given a DMS, S = $\{S_0, S_1, S_2, S_3, S_4\}$ and the probability of occurrence for these symbols are showed in the following table.

k	0	1	2	3	4
S_k	S_0	S_1	S_2	S_3	S_4
p_k	x	$2x$	x	$2x$	0.4

[1 mark]

(a) Determine the value of x.

(b) Complete the following table. Find the amount of information gained by observing the source emitting each of these symbols.

[3 marks]

k	0	1	2	3	4
S_k	S_0	S_1	S_2	S_3	S_4
p_k					
$I(s_k)$					

(c) Calculate the entropy of this source.

[2 marks]

Continued...

(d) Given that the source emits one of five symbols, once every millisecond. Find the information rate of this source.

[2 marks]

(e) Given that an entropy H(s) is 4 bits/symbol. Calculate the second-order extension $H(s^2)$ and third-order extension $H(s^3)$ of the source,

[2 marks]

QUESTION 2

(a) Consider the following codes I and II. Determine whether they are prefix code, uniquely decodable or both.

Symbol	*Code I*	*Code II*
s_0	00	0
s_1	11	10
s_2	100	110
s_3	1100	111

[3 marks]

(b) Compute the Huffman code for the following DMS.

Symbol	**A**	**B**	**C**	**D**	**E**	**F**
Probability	0.3	0.25	0.15	0.15	0.075	0.075

[5 marks]

(c) Based on your Huffman code in Question 2(b), decode the sequence "10110110111" and "00001111110".

[2 marks]

QUESTION 3

Given that P(Y|X) = $\begin{bmatrix} 2/5 & 1/5 & 2/5 \\ 2/3 & 1/3 & 0 \end{bmatrix}$ and $p(x_j) = [5/8 \quad 3/8]$.

(a) Calculate *p(y, x) and* complete the following table.

$p(y_k, x_j)$	y_1	y_2	y_3	$p(x_k)$
x_1				5/8
x_2				3/8
$p(y_k)$				1

[4.5 marks]

$p(y_k, x_j)$	y_1	y_2	y_3	$p(x_k)$
x_1				
x_2				
$p(y_k)$				

(b) Calculate *H(Y)*.

[2 marks]

Continued...

(c) Calculate H(Y|X) and $I(Y, X)$.

[3.5 marks]

QUESTION 4

(a) Given a code C which is defined as $C = \{ c_1 = 0000, c_2 = 1010, c_3 = 0101\}$. Show that C is not linear.

[2 marks]

(b) Consider a linear block code defined by the generator matrix,

$$G = \left[\begin{array}{ccc|cccc} 1 & 1 & 1 & 1 & 0 & 0 & 0 \\ 0 & 1 & 1 & 0 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 \end{array}\right]$$

(i) Compute the parity check matrix, H.

[2 marks]

(ii) Compute the first **SIX** code word and hamming weight for the (7,4) hamming code above.

[6 marks]

Message Word	Code Word	Weight of Code Word
0000		
0001		
0010		
0011		
0100		
0101		
0110		

Continued...

QUESTION 5

Consider the (7, 4) nonsystematic Hamming code defined by the following generator polynomial.

$$g(D) = 1 + D^2 + D^3$$

(a) Find the message polynomial, $m(D)$, of the following input messages:

$$m_1 = 0001, m_2 = 1001, m_3 = 0101, m_4 = 1110$$

[2 Marks]

(b) For each message above, construct code polynomial, $c(D)$.

[2 Marks]

(c) The above code words have been sent over a noisy channel, producing the received code words as follows:

$$r_1 = (0001011), r_2 = (1010011), r_3 = (0100011), r_4 = (1100100)$$

(i) Find the received polynomial, $r(D)$, for each received code word.

[2 Marks]

(ii) Compute the syndrome polynomial, $s(D)$, for each received code word and state which code words have been received with errors.

[4 Marks]

Continued...

QUESTION 6

The generator polynomial for a (7, 4) systematic cyclic code is defined by

$$g(D) = 1 + D + D^2 + D^3$$

(a) Construct the generator matrix, G, in systematic form.

[3 Marks]

(b) Draw the syndrome calculator circuit for the given generator polynomial above.

[2.5 Marks]

(c) Complete the following table to indicate the contents of the syndrome calculator for the received vector r. Assume that the received vector is r = (0110010).

[4.5 Marks]

Shift	Input	Register Contents (Initial 000)

End of Page